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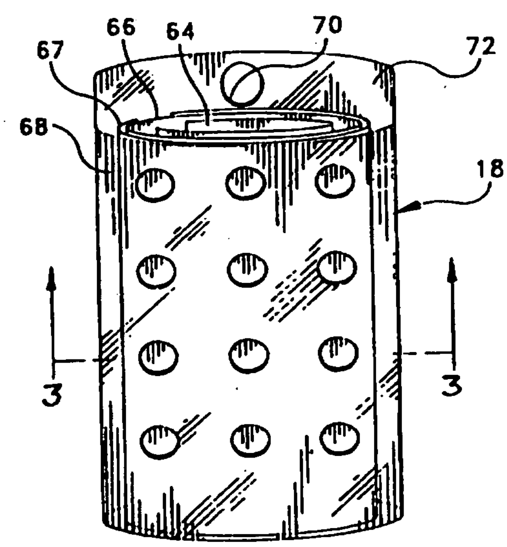
(54) Title: APPARATUS FOR THE CONTROLLED RELEASE OF AN INSECT ATTRACTANT

(57) Abstract

Apparatus (18) for releasing a volatile material into the atmosphere of a constant rate includes a breakable inner container (60) containing a predetermined amount of the volatile material. The inner container (60) is enclosed in a mesh bag (62) which is in turn enclosed in a filter paper (64) and a diffusion membrane (66). To protect a handler from contacting the volatile material on the outer surface of the diffusion membrane (66) the assembly is further enclosed in a second filter paper (67) and a perforated outer membrane (68). The volatile material is absorbed onto inner paper (64), diffuses through the inner diffusion membrane (66) and exits the assembly through apertures in the outer membrane (68).



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APPARATUS FOR THE CONTROLLED RELEASE OF AN INSECT ATTRACTANT

Background and Summary of the Invention:

The instant invention relates to insect trapping techniques, and chemical attractants for mosquitos and related hematophagous insects of the order Diptera, and more specifically to methods of attracting mosquitos using 1-octen-3-ol, and apparatus for releasing 1-octen-3-ol at predetermined release rates.

The use of carbon dioxide and 1-octen-3-ol (octenol) as attractants for hematophagous insects have heretofore been known in the art. Various field studies focusing on the effectiveness of varying release rates of carbon dioxide and octenol have heretofore been conducted, and in this regard, studies conducted by Vale et al, 1985, Bull. ent. Res., 75, 209-217, <u>The Role of 1-octen-3-ol, Acetone, and Carbon Dioxide in the Attraction of Tsetse Flies to Ox Odor</u>; Mushobozy et al, 1993, J. Econ. Entomol. 86(6):1835-1845, <u>Evaluation of 1-octen-3-ol and Nonanol as Adjuvants for Aggregation Pheromones for Three Species of Cucujid Beetles</u>; Atwood et al, 1993, Vol. 9, No. 2 pps. 143-146, <u>Evaluation of 1-octen-3-ol and Carbon Dioxide as Black Fly Attractants in Arkansas</u>; and Kline et al, 1991, J. Med. Entomol. 28(2):254-258, <u>Interactive</u>

<u>effects of 1-octen-3-ol and Carbon Dioxide on Mosquito Surveillance and Control</u> represent the closest prior art to the subject matter of the instant invention of which the applicant is aware.

The study by Vale et al established that lower release rates of octenol were more effective than higher release rates for attracting tsetse flies. More specifically, it was found that a release rate of approximately 5.0 mg/hr of octenol appeared to be most effective. Vale further observed that release rates of octenol of 50-500 mg/hr appeared to act as a repellant although the reasons for this phenomenon were not indicated. The study by Mushobozy indicated that the Cucujid beetles showed a preference for a release rate of about 20 micrograms/hr of octenol. The study by Atwood tested octenol and carbon dioxide as attractants, both alone and in combination, for black flies. While the Atwood study did not measure specific release rates of octenol, it did establish that traps releasing both carbon dioxide and octenol in combination were more effective than traps with octenol alone. The study by Kline is particularly relevant to the instant invention in that it tested varying release rates of octenol and carbon dioxide as attractants for mosquitos. Responses of mosquitos at three levels (0, 3.0 and 41.1 mg/hr) of octenol, four levels (0, 20, 200 and 2,000 ml/min) of

carbon dioxide and their combinations were tested. The 3.0 mg/hr level of octenol resulted in increased trap catches relative to 0 mg/hr, whereas the 41.1 mg/hr level reduced trap catches relative to the 0 mg/hr and the 3.0 mg/hr levels. For the release of octenol, Kline utilized a glass bottle with a rubber septum cover that was in contact with a pipe cleaner wick. When the pipe cleaner was held subsurface to the septum "wick in", it produced a release rate of about 3-5 mg/hr, and when the wick was allowed to extend above the septum "wick out" it produced a release rate of about 40 mg/hr.

Despite the findings of the above field studies, very few, if any, people have studied the biological response mechanisms in mosquitoes that are responsible for response to carbon dioxide and octenol. Thus, while the scientific community is aware that carbon dioxide and octenol are operative as attractants, the biological responses that underlie the phenomenon are generally not understood.

The instant invention provides specific release rates for octenol for use as a mosquito attractant, and further provides apparatus for releasing octenol into the air at the desired release rate. The release rate for octenol as disclosed herein was determined by electrophysiology studies conducted on the basiconic pegs located on the distal end of the maxillary palps of

female mosquitos. It was determined that a single neurons in a single basiconic palpal peg is responsible for the mosquitoes response to octenol. The firing rates of this specific neuron was studied in order to determine their normal firing rate and how the neuron reacted to different levels of octenol. Through these electrophysiology studies, it was determined that the optimal release rate octenol was much lower (on the order of 5 to 10 times lower) than any release rates previously tested by others. More specifically, it was determined that a dose rate of about 0.1 - 1.0 mg/hr of octenol produced the most consistent firing rates in the neuron in the operable range. Higher dose rates of octenol caused the neuron to overload and shut down completely, thereby disabling the mosquitos differential sensing capabilities. It was further found that a dose rate of approximately 0.5 mg/hr of octenol provided the most flight activity during field testing.

The apparatus for releasing octenol at a rate of approximately 0.5 mg/hr comprises a slow-release plastic diffusion packet including a crushable vial containing about 1 milliliter of octenol. The vial is contained within a plastic web mesh to capture the vial fragments when crushed. The web mesh is in turn surrounded by a filter paper to absorb the octenol. The vial, plastic web and filter paper are sealed within a LDPE plastic bag.

The surface area and thickness of the plastic bag were selected to provide the desired release rate of octenol which slowly diffuses through the plastic bag. The slow release packet is attached to a trap to draw mosquitos into the vicinity.

Accordingly, it is an object of the instant invention to provide a method of attracting mosquitoes by releasing octenol into ambient air at a rate of about 0.1 to 1.0 mg/hr.

It is another object to provide apparatus for releasing octenol at a predetermined release rate.

Other objects, features and advantages of the invention shall become apparent as the description thereof proceeds when considered in connection with the accompanying illustrative drawings.

Description of the Drawings:

In the drawings which illustrate the best mode presently contemplated for carrying out the present invention:

Fig. 1 is an elevational view, partially in section, of a light/fan trap incorporating the features of the instant invention;

Fig. 2 is a perspective view of a slow-release octenol packet constructed in accordance with the teachings of the instant invention;

Fig. 3 is a cross-sectional view thereof taken along line 3-3 of Fig. 2; and

Fig. 4 is an assembly view thereof.

Description of the Preferred Embodiment:

Referring now to the drawings, a mosquito trap incorporating the features of the instant invention is illustrated and generally indicated at 10 in Fig. 1. As will hereinafter be more fully described, the instant mosquito trap 10 utilizes both carbon dioxide and octenol as attractants for attracting mosquitoes to the trap.

The mosquito trap comprises a fan/light assembly generally indicated at 12, a carbon dioxide canister generally indicated at 14, and a trap net generally indicated at 16. A slow release octenol packet for attachment to the trap 10 is generally indicated at 18 in Figs. 1-4.

The fan/light assembly 12 comprises a cylindrical body portion 20 having an open bottom 22, and a hollow cylindrical neck portion 24 which extends upwardly and terminates in a head portion 26. The head portion 26 includes outward threads 28 at the top thereof for threaded engagement with a cap of the carbon dioxide canister 14. The fan/light assembly 12 further includes an internal fan 30 which is capable of developing a downwardly directed air flow of about 500 l/min, and a

light source 32 positioned in the neck portion 24 thereof. The head portion 26 encloses an electronics package (not shown) which is operable for controlling the fan 30 and light 32 of the assembly 12. A stainless steel screen 34 is provided at the top of the body portion 20 to prevent the entry of larger insects into the trap body 20. The body portion 20 further includes an external hook 36 for supporting the slow release octenol packet 18.

The carbon dioxide canister 14 comprises a molded plastic cap generally indicated at 38, an insulated container generally indicated at 40 and a removable top 42. The plastic cap 38 includes an inwardly threaded hub (not shown) for threaded engagement with the outwardly threaded head portion 26 of the light/fan assembly 12. The cap 38 further includes a wide flange 44 for protecting the fan/light assembly 12 from inclement weather. The container 40 includes a rugged polypropylene liner 46 which is preferably large enough to hold at least 3 1/2 pounds of dry ice and is preferably insulated with rigid foam insulation 48 such that the dry ice is allowed to sublimate at a rate of approximately 500 ml/min. A port 50 extends downwardly from the container 40 through the cap 38 to allow the sublimated carbon dioxide to be drawn downwardly by the fan 30 into the interior of the trap body 20. A perforated manifold 52 in

the bottom of the container 40 prevents the dry ice from blocking the exit port 50. In use, sublimated carbon dioxide is drawn downwardly into the 500 l/min air flow within the body portion 20 to provide a constant concentration of about 1000 ppm at the open bottom 22 of the body portion 20.

In the alternative, carbon dioxide from a tank (not shown) can be supplied to the interior of the neck portion 24 by means of a hose 59. The flow rate of carbon dioxide from the tank is regulated by a conventional flow regulator to achieve the desired 500 ml/min flow rate.

Based on prior research it has been determined that mosquitos apparently navigate via a differential sensing of carbon dioxide concentrations that are on the order of parts per million. By detecting concentration differences on their stereo sensillum, the mosquito determines which direction to fly. Since mosquitos apparently utilize a differential concentration of carbon dioxide in their host approach, they navigate towards higher and higher concentrations of carbon dioxide, i.e. towards the source of carbon dioxide which is usually a potential host. However, the neurons which sense carbon dioxide have a threshold limit above which they become disoriented. This limit has been determined to be around 1000 ppm. The instant fan trap 10 presents the carbon dioxide only to the interior of the trap body 20 to provide a dose rate

in the vicinity of 1000 ppm at the plume exit (open bottom 22) of the trap body 20. The carbon dioxide sublimated in the instant trap 10 is drawn downwardly through the center of the trap 10 by virtue of a lower pressure created by the fan 30, and is mixed with ambient air within the trap body 20. The air flow exits the trap bottom 22 and is dispersed through the trap net 16. The concept of the idea is that the mosquitos will navigate the plume to the trap entrance (screen 24) without being repelled or caused to turn away from the trap 10 due to too high a concentration. It is theorized that the mosquitos will navigate the perimeter of the air flow plume into the vicinity of the trap entrance. Near the trap entrance they will be drawn into the trap via the fan suction and captured in the trap net 16.

The trap net 16 is constructed from a fine mesh material to allow air flow, yet prevent the escape of even the smallest mosquitos. The trap net 16 is generally cylindrical in shape and it has drawstrings 54 and 56 respectively at the top and bottom thereof. The top draw string 54 allows the trap net 16 to be tightly drawn around the open bottom 22 of the trap body 20. The bottom draw string 56 allows the mosquitos to be emptied from the net 16. The trap net 16 may further include props 58 for suspending the net in an open position. The trap net 16 may also be disposable so that the operator

may simply close the net 16 at the ends and throw the full net away.

The slow release octenol packet 18 is operable for releasing octenol to ambient air at a rate of about 0.5 mg/hr and it comprises a crushable glass vial 60 (Fig. 7) containing about 1 ml of octenol. The glass vial 60 is contained within a plastic mesh sleeve 62 to capture the glass vial fragments when crushed. The plastic mesh sleeve 62 is in turn surrounded by an absorbent material 64, such as a layer of filter paper, to absorb and disperse the octenol over a larger surface area. The glass vial 60, plastic mesh sleeve 62 and absorbent filter paper 64 are in turn sealed within a polymeric diffusion membrane 66. In the instant embodiment, the diffusion membrane 66 comprises a 6 mil LDPE plastic bag having an outer surface area of about 13.5 square inches. In this connection, the plastic bag 66 was formed from 6 mil plastic tubing having a flat width of 3 inches. The cylindrical tubing was laid flat and sealed at the top and bottom edges to provide a linear length of 2.25 inches. The octenol release packet 18 further comprises a second layer of filter paper 67 wrapped around membrane 66 and an external perforated jacket 68. The filter paper 67 and membrane 68 permit the octenol to evaporate into the air but prevent skin contact with the octenol on the surface of the diffusion membrane 66. The external

jacket 68 is also constructed from LDPE plastic and it further includes flap 70 at the top thereof with an aperture 72 therein for mounting onto the external hook 36 of the trap body 20.

The optimal release rate of 0.5 mg/hr was determined partly by electrophysiology studies conducted on female mosquitos at the Worcester Foundation For Experimental Biology and partly by behavioral testing at the insectary of American Biophysics Corp, In Jamestown, RI.

EXPERIMENTAL PROCEDURE AND RESULTS

There are three neurons present in the basiconic sensillum located at the distal end of the maxillary palps of female mosquitos. Of the three neurons, one is highly responsive to the presentation of octenol. Standard electrophysiology recording techniques were used to record extracellular responses from the receptor neuron. (See Grant et al, 1989 <u>Pheromone-Mediated Sexual Selection in the Moth Utetheisa Ornatrix: Olfactory Neurons Responsive to a Male-Produced Pheromone</u>, J. Insect Behav. 2:371-385). Mosquitos were mounted on a microscope stage with adhesive and double-sided tape. A tungsten recording electrode was inserted at the sensillum base and an indifferent electrode was place in the eye. Two gas streams were directed toward the exposed palp, one carrying the background and the other

the stimulus. Computer activated valves controlled the delivery of gas to the mosquito preparation. 1-octen-3-ol was dosed at approximately 1 milligram (1 microliter reagent) onto a filter paper approximately 3 mm by 20 mm and inserted into a 2 inch glass cartridge with Luer taper fittings on both ends. The cartridge was directed on a mosquito preparation with synthetic mixed air, including carbon dioxide of known concentration, running through it. The exact dose rate of octenol was not quantifiable due to the fluctuating background flow. A similar setup with filter paper but no chemical was presented from the other side of the insect, and suitable valves were provided to redirect air flow under computer control. This setup is more completely described in Grant et al, as indicated above.

As noted, a 1 milligram sample was used in all preliminary work up to August 12, 1993. With the presentation of 1-heptanol or 1-octen-3-ol, one of the two secondary neurons began firing almost immediately when the cartridge was placed near the insect, and before a stimulus stream was even provided. On closer examination, the firing rate of the neuron quickly rose to its maximum capability of some 150-200 impulses per second and then completely shut down. The normal firing range for the neuron was found to be approximately 10-150 impulses per second. In some cases the neuron would

recover after several seconds to several minutes of clean air, but in other cases, the neuron seemed to never recover. It was thus determined that the dose rate of octenol provided in these preliminary tests was much too high. In tests conducted after August 12, 1993, a new cartridge was utilized wherein the dosage of octenol was reduced by a factor of 1000 by dilution with distilled water. The 1 microgram cartridge was then presented to the insects without causing the secondary neuron to cease firing during the stimulation period. Again it was pointed out that the exact dose rate of octenol was not quantifiable due to the background flow rate. Meaningful rates of firing increases in one of the secondary neurons were then noted with the presentation of octenol at the reduced dosage level. The neuron subsided to a normal tonic level immediately after stimulus presentation. It was thus determined that the dose rates of octenol previously tested (i.e. in the range of 3.0 - 40.0 mg/hr) were much too high to be effective.

Based on the information gathered in the electrophysiology test, behavioral tests were then run in the insectary of American Biophysics during the middle two weeks of September 1993 to examine behavioral responses of Aedes aegypti to presentations of various dosage levels of 1-octen-3-ol. In order to significantly reduce the dose levels previously tested it was

determined that a diffusion membrane would provide a significantly reduced dose rate. Low density polyethylene tubing of two sizes were obtained for the construction of slow release packets. The first tubing was 4 mils thick and 2 inches in flat width. The second tubing was 6 mils thick and 3 inches in flat width. One milliliter of octenol was loaded into each tubing size and sealed at both ends. Sample packages were made in the following dimensions:

4 mil - 2 inches wide by 10 inches long
4 mil - 2 inches wide by 2 inches long
6 mil - 3 inches wide by 6 inches long
6 mil - 3 inches wide by 2 inches long.

The sealed bags were allowed to sit for two hours to allow the internal vapor pressure to permeate the LDPE membrane. The bags were then pulled through a small opening into the insectary with a pulley arrangement to observe the results (on closed circuit television) of the stimulus presentation, without prejudicing the outcome by having a human enter the room.

It was noted that the octenol did not stimulate the mosquitos to flight in any of the concentrations presented. An artificial stimulation by carbon dioxide gas was required to cause the mosquitos to fly from their resting positions. This behavior indicated that the

mosquitos utilize both carbon dioxide and octenol in their host seeking navigation.

Once stimulated to flight with the carbon dioxide, the octenol presented in the higher concentrations, i.e. the 4 mil bags, seemed to thwart the general flight behavior of the mosquitoes in the vicinity of the attractant bags, i.e. appeared to act as a repellent. However, the 6 mil package having the 2 inch length provided the most flight activity in the area of the stimulant package after the mosquitos were activated to flight by a 5 second burst of 100% carbon dioxide flowing at a rate of 100 milliliter per minute into the insectary near the mosquito cage.

A 6 mil sample bag was then weighed on a balance over time to determine the release rate provided by the 6 mil barrier. The release rate was determined to be approximately .037 milligrams/per square inch/per hour. The 6 mil 2 inch long by 3 inch wide package has a total surface area of approximately 12 square inches. Accordingly, the release rate of octenol from the 6 mil 2 inch bag was about 0.44 mg/hr.

It can therefore be seen the instant invention provides an optimal release rates of octenol, as well as apparatus for releasing octenol at the optimum release rate. It can be seen that the slow release octenol packet of the instant invention provides a release rate

of octenol (0.5 mg.hr) which is significantly lower (by a factor of 5-10 times lower) than those previously studied. The lower release rate of octenol gives a more consistent and better effect than the prior release rates heretofore known. Furthermore, the lower octenol release rate also prevents damage to the sensory neuron structure thereby affording a better opportunity to capture the mosquitos. For these reasons, the instant invention is believed to represent a significant advancement in the art which has substantial commercial merit.

While there is shown and described herein certain specific structure embodying the invention, it will be manifest to those skilled in the art that various modifications and rearrangements of the parts may be made without departing from the spirit and scope of the underlying inventive concept and that the same is not limited to the particular forms herein shown and described except insofar as indicated by the scope of the appended claims.

Claims:

1. Apparatus for releasing a liquid insect attractant at a constant rate comprising:

a breakable inner container containing a predetermined amount of said liquid insect attractant; and

a polymeric diffusion membrane enclosing said inner container, said insect attractant diffusing through said polymeric diffusion membrane, and evaporating from an outer surface thereof.

2. The apparatus of claim 1 further comprising an absorbent material disposed between said inner container and said polymeric diffusion membrane for absorbing said insect attractant and dispersing said insect attractant over a large surface area after said inner container is broken.

3. In the apparatus of claim 1, said breakable inner container comprising a crushable glass vial.

4. The apparatus of claim 1 further comprising a porous web enclosing said glass vial for retaining glass fragments when said vial is crushed.

5. In the apparatus of claim 4, said porous web comprising a plastic mesh sleeve.

6. The apparatus of claim 1 further comprising a gas permeable membrane surrounding said diffusion membrane.

7. In the apparatus of claim 6, said gas permeable membrane comprising a polymeric membrane having a plurality of apertures therein.

8. In the apparatus of claim 1, said polymeric diffusion membrane comprising LDPE plastic.

9. In the apparatus of claim 1, said insect attractant comprising 1-octen-3-ol.

10. In the apparatus of claim 9, said polymeric diffusion membrane comprising 6 mil LDPE plastic having a total surface area of about 13.5 square inches.

11. Apparatus for releasing a volatile material into the atmosphere at a constant rate comprising:

a breakable inner container containing a perdetermined amount of said volatile material; and

a diffusion membrane enclosing said inner container, said voltaile material diffusing through said diffusion

membrane and evaporating from an outer surface of said membrane when said inner container is broken to release said volatile material into contact with an interior surface of said membrane.

12. The apparatus of claim 11 wherein said volatile material comprises a volatile liquid, said apparatus further comprising an absorbent material layer disposed between said inner container and said diffusion membrane, said absorbent material absorbing said volatile liquid and dispersing said volatile liquid over a large surface area after said inner container is broken to release said volatile liquid.

13. The apparatus of claim 11 wherein said breakable inner container comprises a glass vial.

14. The apparatus of claim 13 further comprising a porous web enclosing said glass vial.

15. The apparatus of claim 11 further comprising a gas permeable membrane surrounding said diffusion membrane.

16. The apparatus of claim 15 wherein said gas permeable membrane comprises a polymeric membrane having a plurality of apertures therein.

17. The apparatus of claim 12 further comprising a gas permeable membrane surrounding said diffusion membrane.

18. The apparatus of claim 17 wherein said gas permeable membrane comprises a polymeric membrane having a plurality of apertures therein.

19. The apparatus of claim 15 further comprising a second absorbent material layer disposed between said diffusion membrane and said gas permeable membrane.

20. The apparatus of claim 19 wherein said gas permeable membrane comprises a polymeric membrane having a plurality of apertures therein.

21. Apparatus for releasing a volatile liquid into the atmospohere at a constant rate comprising:

a breakable inner container containing a perdetermined amount of said volatile liquid;

a gas permeable membrane enclosing said inner container; and

an absorbent material layer disposed between said inner container and said gas permeable membrane, said absorbent material absorbing said volatile liquid and dispersing said volatile liquid over a large surface area

after said inner container is broken to release said volatile liquid.

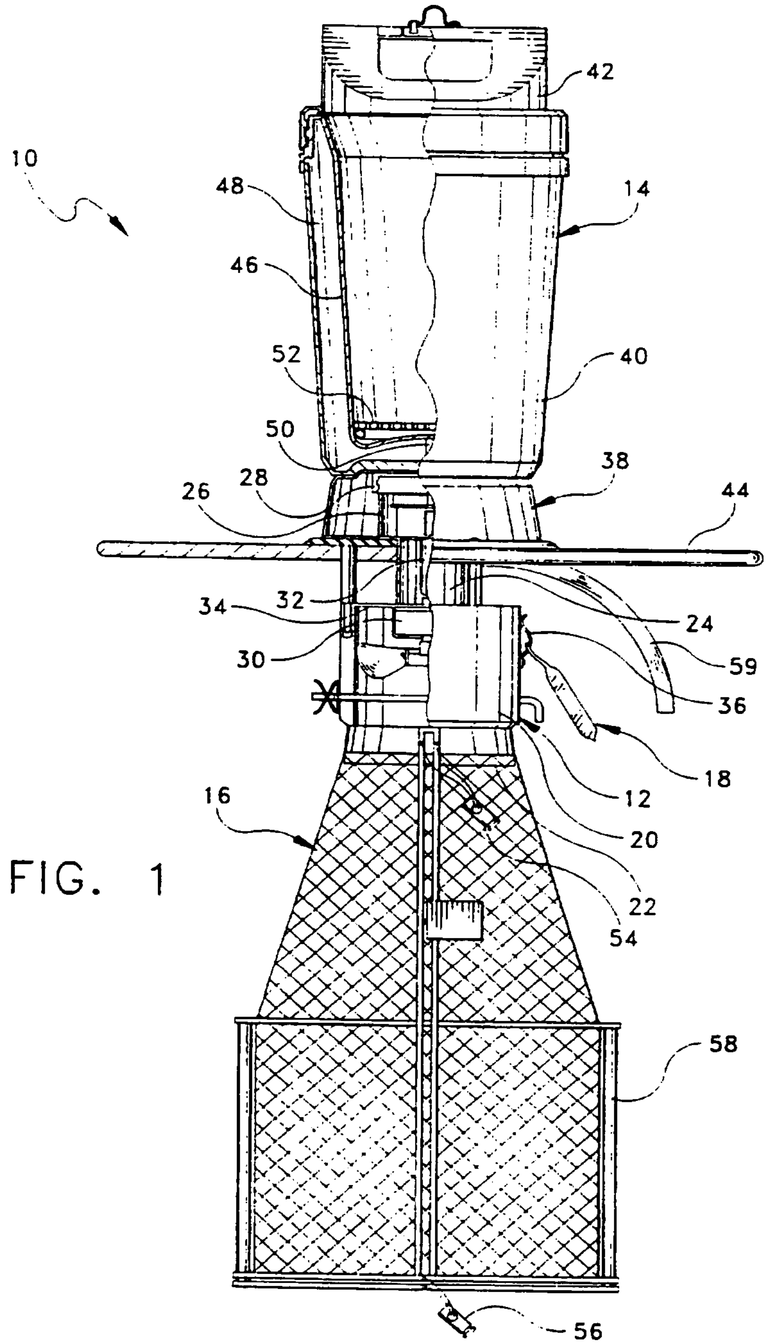
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FIG. 1

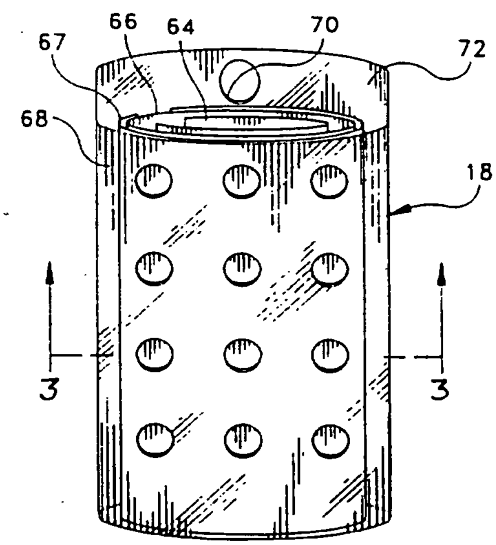

FIG. 2

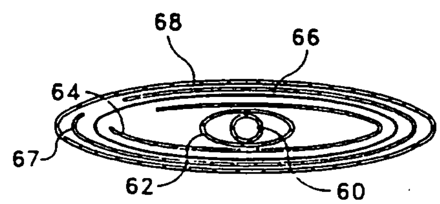

FIG. 3

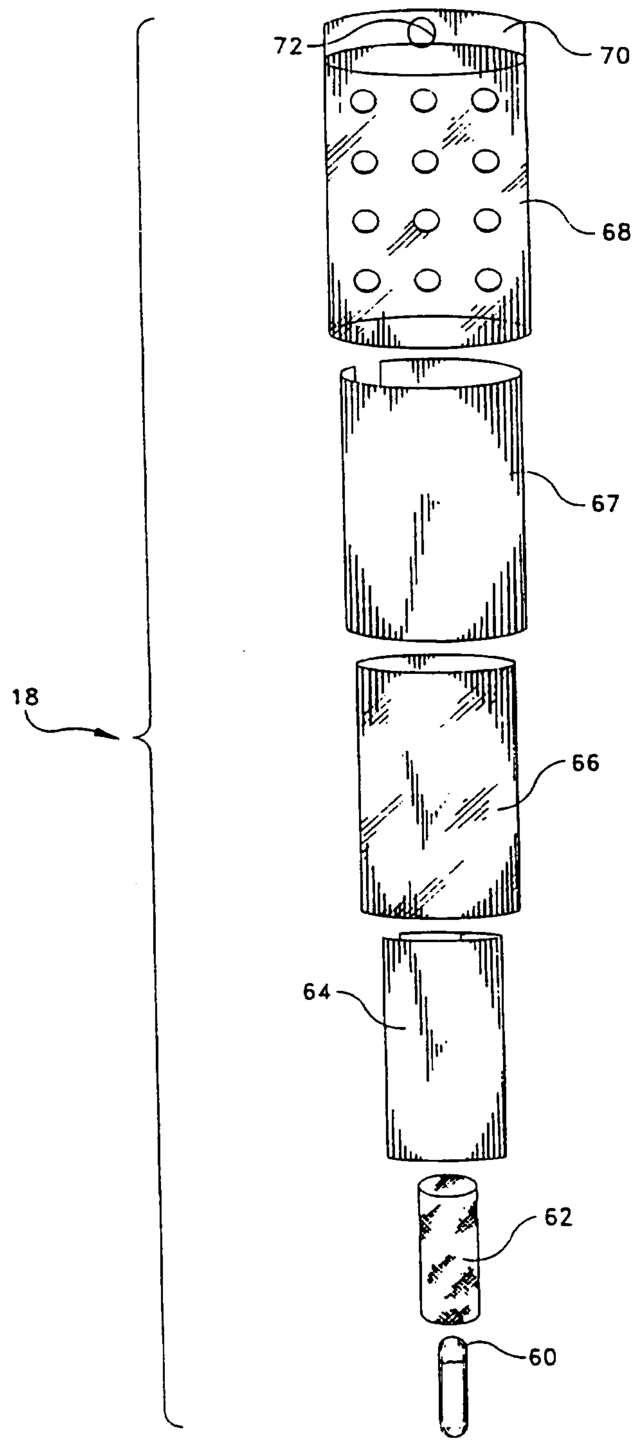

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/01219

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A01L 1/02, 13/00; A61 L 9/04
US CL :239/45, 51.5, 44, 34; 43/129
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 239/45, 51.5, 44, 34, 47, 53, 55, 57; 43/129, 113; 206/205

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---- Y	US, A, 3,702,677 (HEFFINGTON) 14 NOVEMBER 1972, see figure 4.	11-13, 15, 17, 19,21 ---- 16, 18, 20
X --- Y	US, A, 1,991,938 (HOUGHTON) 19 FEBRUARY 1935, see figure 1.	11-15, 17, 21 ---- 1-4, 6-10, 16, 18, 20
X --- Y	US, A, 5,161,680 (BADGLEY) 10 NOVEMBER 1992, see figure 3.	11-13,21 ---- 14

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/01219

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 2,209,914 (GERBER ET AL.) 30 JULY 1940, see figure 3.	11, 12, 15, 17, 21
Y	US, A, 2,342,046 (LATTA ET AL.) 22 FEBRUARY 1944, see figure 6.	14
Y	US, A, 4,161,283 (HYMAN) 17 JULY 1979, see col. 3, line 55 through col. 4, line 5.	16, 18, 20
Y	US, A, 4,285,268 (HYMAN) 25 AUGUST 1981, see col. 4, lines 23-43.	16, 18, 20
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Y	Journal of the American Mosquito Control Association, Volume 9, No. 2, issued June 1993, Atwood et al., "Evaluation of 1-octen-3-ol and Carbon Dioxide as Black Fly Attractants in Arkansas", pages 143-146, especially pages 143 and 144.	1-4, 6-10
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Y	Journal of Economic Entomology, Volume 86, No. 6, issued December 1993, Mushobozy et al., "Evaluation of 1-octen-3-ol and Nonanol as adjuvants for Aggregation Pheromones for Three Species of Cucujid Beetles", pages 1835-1845, especially page 1834.	1-4, 6-10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/01219

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 2,209,914 (GERBER ET AL.) 30 JULY 1940, see figure 3.	11, 12, 15, 17, 21
Y	US, A, 2,342,046 (LATTA ET AL.) 22 FEBRUARY 1944, see figure 6.	14
Y	US, A, 4,161,283 (HYMAN) 17 JULY 1979, see col. 3, line 55 through col. 4, line 5.	16, 18, 20
Y	US, A, 4,285,268 (HYMAN) 25 AUGUST 1981, see col. 4, lines 23-43.	16, 18, 20
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Y	Journal of Medical Entomology, Volume 28, No. 2, issued March 1991, Kline et al., "Interactive effects of 1-octen-3-ol and Carbon Dioxide on Mosquito Surveillance and Control", pages 254-258, especially pages 254 and 255.	1-4, 6-10
Y	Journal of Economic Entomology, Volume 86, No. 6, issued December 1993, Mushobozy et al., "Evaluation of 1-octen-3-ol and Nonanol as adjuvants for Aggregation Pheromones for Three Species of Cucujid Beetles", pages 1835-1845, especially page 1834.	1-4, 6-10

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